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Two experiments which compare the effectiveness of the auditory and visual elements in instructional films in order to study their relative contributions to learning are described in this paper. Two films dealing with aerodynamics were used in one experiment, and one film dealing with desert survival was used in the other. Multiple choice item tests were constructed covering the information in each film. Some of the items were based on information contained in the visuals, others on the commentary, and a third group on information to be found in both the visual and audio channels. Some items were visual, and some verbal. The aerodynamics films were shown to 430 ROTC trainees divided at random into eight test groups. The experiments, concerned with the overall effectiveness of the audio and video elements, yielded the following main conclusions: (1) Significant learning accrues from the presentation of the film as a whole, and from the presentation of either the audio or video channel alone. 2. Neither channel is consistently better than the other. 3. Both channels together are consistently better than either one alone. 4. In general, hearing the sound track in the dark appears to be slightly superior to hearing it in the light. (GO)

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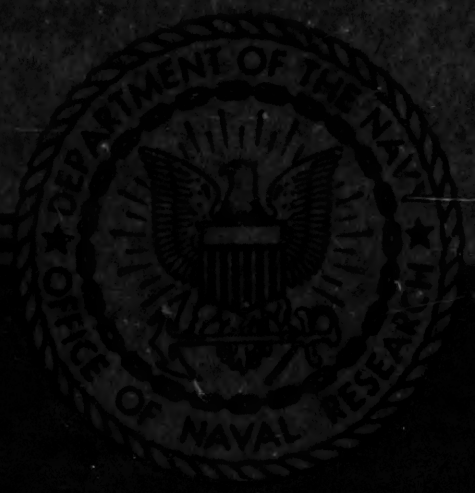
COMPARISON OF THE AUDIO AND VIDEO ELEMENTS OF INSTRUCTIONAL FILMS

(Rapid Mass Learning)

The Pennsylvania State College
Instructional Film Research Program
November 1950

Project Designation NR-781-005
Contract N6onr-269, T.O. VII
SDC Human Engineering Project 20-E-4



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COMPARISON OF THE AUDIO AND VIDEO ELEMENTS OF INSTRUCTIONAL FILMS

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SUMMARY

This report deals with two experiments in which the effectiveness of the auditory and visual elements in instructional films were compared in order to study their relative contributions to learning.

Procedure

Two films dealing with aerodynamics (Theory of Flight and Problems of Flight were used in one experiment; the other experiment used a film entitled Land and Live in the Desert, dealing with desert survival.

Multiple choice item tests were constructed covering the information in each film. Some of the items were based on information contained in the visuals, others were based on the commentary, and items in a third group were based on information to be found in both the visual and auditory channels. Some of the items in the test were in picture form, the others were verbal.

The aerodynamics films study used 430 ROTC trainees divided at random into eight test groups as follows:

Group A (control group) did not see or hear either film.

Group B saw and heard Theory of Flight only.

Group C saw and heard both films.

Group D saw and heard Theory of Flight, but only saw Problems of Flight.

Group E_1 saw and heard Theory of Flight, but only heard Problems of Flight in the dark.

Group E_2 saw and heard Theory of Flight, but only heard Problems of Flight in the light.

Group F only heard both films (in the dark).

Group G only saw both films.

The desert survival film experiment used 388 college students divided at radom into five test groups as follows:

Group C (control group) did not see or hear the film.

Group AL only heard the film in the light.

Group AD only heard the film in the dark.

Group V only saw the film.

Group B both saw and heard the film.

Immediately after the film showing the tests were administered.

Results

Means for the various groups were compared. In every case the groups which had some film treatment were better than the control groups which did not see or hear any film. Furthermore, the groups which both saw and heard a film were better than the groups which only saw or heard the film. In both studies hearing the sound track in the dark was slightly more effective than hearing it in the light.

In order to study the relative effectiveness of the audio and video elements in the films, a "least squares" analysis was made. Weights were determined for an audio factor, a video factor and a "both" factor. In addition, a constant K was included to represent the extent of previous knowledge of the subject.

For the film Theory of Flight the video factor was very much more important than the audio in contributing to the total effectiveness of the film. For Problems of Flight the audio factor was somewhat more important than the video factor. For these two films the "both" factors were small but positive, indicating that some items were taught by both the audio and video factors working together.

For Land and Live in the Desert the audio factor was slightly more important than the video factor in contributing to the total effectiveness of the film. The "both" factor for this film was quite large and negative, indicating that there was some overlap of the audio and video elements in teaching certain items.

Conclusions

The two experiments reported here were concerned with the overall effectiveness of the audio and video elements in contributing to total learning from some typical instructional films. The experiments were not concerned with the relative efficiency of the two media, visual and auditory. This latter question poses some difficult experimental problems.

The results of the experiments indicate;

1) Significant learning accrued from the presentation of the film as a whole, and from the presentation of either the audio or video channel alone.

2) Neither channel was consistently better than the other. The relative effectiveness seems to depend on the particular film and its content.

3) Both channels together were consistently better than either one alone.

4) A "both" factor was identified. Where this is a "plus" factor, as in the aerodynamics films study, it indicates that some items are taught jointly by the audio and video working together; where it is a "minus" factor, as in the desert survival film study, it indicates that some items are taught in both the audio and video channels (i. e., there is some overlapping).

5) In general, hearing the sound track in the dark appears to be slightly superior to hearing it in the light.

Implications

1. Both audio and video elements of films are effective channels of communication. Each channel is uniquely capable of conveying certain types of information. However, since both channels together are more effective than either one alone, the object should be to achieve the best possible integration of the video and audio elements of films.

2. The findings of these studies appear to be relevant to television.

COMPARISON OF THE AUDIO AND VIDEO ELEMENTS OF INSTRUCTIONAL FILMS

by

Harold E. Nelson and Karl R. Moll

INTRODUCTION

This report summarizes the findings of two experiments in which the effectiveness of the audio and video elements in instructional films were compared in order to study their relative contributions to learning. One of these studies was conducted by Dr. Harold Nelson. Dr. Nelson studied two films dealing with aerodynamics, Theory of Flight and Problems of Flight. The other study, conducted by Mr. Karl Robert Moll, used the film Land and Live in the Desert.

PROCEDURE

The Films

The film Theory of Flight shows general principles of aerodynamics. It used various types of models and visual aids to demonstrate these principles. The film Problems of Flight shows these principles of aerodynamics applied to an airplane in flight.

Land and Live in the Desert is an instructional film with a dramatic plot. It is concerned with the fight for survival, and the rescue of a bomber crew forced down in the desert. The film shows (and tells) how to survive in the desert with a minimum of water, how to gain protection from the desert heat, how to set up rescue signals, and so on.

The Tests

In both studies, multiple-choice items with four alternatives were used. For the aerodynamic films study, 90 items were prepared covering material in both films. These items were pre-tested and analyzed, and examined by subject-matter experts. Sixty-five items were finally selected for the test. Some of the items were pictorial, while others were verbal.

For the desert survival film, 100 items were prepared and pre-tested. These items represented an exhaustive gleaning of the information in the film. The pre-test group consisted of 80 speech students at The Pennsylvania State College. Seventy-six items were selected for the final test.

Some of the items in each test were based on material in the visuals, others were based on the commentary, and items in a third group were based on information to be found in both the video and audio elements of the films.

The Subjects

The test population for the aerodynamic films consisted of 430 members of the Reserve Officer Training Corps at The Pennsylvania State College. None of the men had received previous training in aerodynamics.

The test population for the desert survival film consisted of 388 students enrolled in the 1949 Summer Session at The Pennsylvania State College. The students were mainly in their junior and senior years, predominantly male, and extremely heterogeneous with regard to major course study. The modal age was 23.

Experimental Procedure

The 430 subjects in the aerodynamic films test population were divided at random into eight test groups. The eight groups were subjected to the following individual test situations.

Group A (control group) did not see or hear either film.

Group B saw and heard Theory of Flight only.

Group C saw and heard both films.

Group D saw and heard Theory of Flight, but only saw Problems of Flight.

Group E_1 saw and heard Theory of Flight, but only heard Problems of Flight in the dark.

Group E_2 saw and heard Theory of Flight, but only heard Problems of Flight in the light.

Group F only heard both films (in the dark).

Group G only saw both films.

Standardized test instructions were read to each group before the film showings. Following the film showings the tests were administered.

The 388 students in the study using Land and Live in the Desert were divided at random into five test groups. These groups were as follows:

Group C (control group) neither saw nor heard the film.

Group AL only heard the film, in the light.

Group AD only heard the film, in the dark.

Group V only saw the film.

Group B both saw and heard the film.

RESULTS

Aerodynamics Films Study

For each study, mean scores were obtained for each of the groups used in the experiment. Critical ratios were calculated between pairs of selected means.

Table 1 shows the means and standard deviations for each of the eight groups in the aerodynamics films study, and the type of film showing to which each group was subjected. As Table 1 shows, each of the groups learned a considerable amount of information as compared with the Control group (A) which did not see or hear either film. Table 1 also shows that Group C, which saw and heard both films, earned the highest mean score.

Table 2 shows selected critical ratios between pairs of groups. From the first line of the body of Table 2 it is clear that each experimental group performed significantly better than the no-film group. The second line compares the performance of Group B with Groups C, D, and E_1. Each of these four groups saw and heard the Theory of Flight film; Group B did not see or hear the Problems of Flight film; Group C both heard and saw this film; Group D only saw this film; Group E_1 only heard this film. Groups C, D, and E_1, all did better than Group B, although in the case of Group D the difference was not significant. This result is not surprising since Group B did not see or hear Problems of Flight, whereas Groups C, D, and E_1, either heard or saw this film or both. This substantiates the previous finding that some information

TABLE 1

Aeordynamics Films Study

FILM PRESENTATIONS GIVEN
TO EACH GROUP AND SCORES EARNED BY EACH GROUP

Group	No. in Group	Theory of Flight		Problems of Flight		Mean	Standard Deviation
		Video (saw)	Audio (heard)	Video (saw)	Audio (heard)		
A (control group)	60	No	No	No	No	28.9	6.98
B	49	Yes	Yes	No	No	37.7	6.34
C	48	Yes	Yes	Yes	Yes	44.9	8.68
D	66	Yes	Yes	Yes	No	39.5	6.91
E_1	61	Yes	Yes	No	Yes (in dark)	42.5	7.26
E_2	51	Yes	Yes	No	Yes (in light)	40.7	8.33
F	49	No	Yes	No	Yes	33.6	9.77
G	46	Yes	No	Yes	No	37.8	6.52

Maximum Possible Score - 65

TABLE 2

Aerodynamics Films Study

CRITICAL RATIOS BETWEEN MEANS OF TOTAL SCORES FOR PAIRS OF EXPERIMENTAL GROUPS

Groups	B	C	D	E_1	E_2	F	G
A	+6.94***	+10.38***	+8.57***	+10.55***	+8.05***	+2.84**	+6.78***
B		+ 4.62***	+1.41	+ 3.69***			
E_1			-2.41*		-1.21		
F							+2.49*

* 1.96 = 5% level of confidence
** 2.58 = 1% level of confidence
*** 3.29 = 0.1% level of confidence

A minus sign indicates that the group listed on the side is superior to groups listed across the top.

is imparted by both the audio and video media. The third line compares Group E_1 with Group E_2, and shows that hearing the second film in the dark was better, but not significantly so, than hearing it in the light. Groups E_1 and D are also compared, and here a significant difference was obtained in favor of hearing rather than seeing the Problems of Flight film. The last line of the table shows a different finding: when Groups F and G are compared, the difference is in favor of the group that saw both films as opposed to the group that heard both films.

Table 3 shows the relative "weights" of seven factors as determined from a "least squares" analysis. The four main factors are Vt (Video in the Theory film), At (Audio in the Theory film), Vp (Video in the Problems film) and Ap (Audio in the Problems film). In addition, a "both" factor was found for each film. The "both" factor accounts for that portion of the effectiveness of each film which cannot be attributed to either the audio or video factors separately, or to previous knowledge of the subject. In this study the "both" factor was positive (i.e. carried a + sign) for each film, indicating that both the audio and video together were essential for the imparting of certain items of information. The constant K takes into account the test score of the control group that did not see or hear either film, and has no special significance except to indicate the extent of previous knowledge prior to the film showings. Table 3 summarizes the general effectiveness of these factors. It appears that while in the Theory film the video factor is much more important than the audio factor, in the Problems film the audio factor is more important than the video.

Desert Survival Film Study

Table 4 shows the means and standard deviations for the five groups that participated in the Land and Live in the Desert film study. The statistics for the Audio-Light and Audio-Dark groups combined are also shown. As in the aerodynamics films study, the control group (no film) obtained the lowest score while the group that both saw and heard the film obtained the highest score.

Table 5 shows selected critical ratios between pairs of groups. The first line shows that the differences between the control group on the one hand, and the audio, video, and "both" groups on the other hand, were all significant at an extremely high level, in favor of some kind of film showing. The second line shows that the audio group did significantly better than the video group, but not as well as the "both" group. The third line shows that the "both" group did significantly better than the video group. The last line compares the "audio in the light" group with the "audio in the dark" group. As in the first study, the difference was in favor of the "audio in the dark" group.

TABLE 3

Aerodynamics Films Study

RELATIVE WEIGHTS OF THE FACTORS MAKING UP THE TOTAL SCORES

Vt = 7.1

At = .8

Vp = 1.8

Ap = 3.9

Bt = .9

Bp = 1.5

K = 28.9

V = Video

A = Audio

B = Both

t = Theory of Flight Film

p = Problems of Flight Film

K = Control Group Constant

TABLE 4

Land and Live in the Desert Study

SCORES EARNED BY EACH GROUP

Group	N	Mean	Standard Deviation
C (no film)	81	29.1	4.86
AL (heard only in light)	73	46.2	5.24
AD (heard only in dark)	79	48.4	6.17
A*	152	47.4	5.85
V (saw only)	80	45.6	4.75
B (saw and heard)	75	57.3	5.01

Maximum Possible Score - 76

* The A group represents the AL and AD groups combined.

TABLE 5

Land and Live in the Desert Study

CRITICAL RATIOS BETWEEN MEANS OF TOTAL SCORES FOR PAIRS OF EXPERIMENTAL GROUPS

Groups	A	V	B	AL
C	25.29***	21.65***	35.41***	
A		-2.46*	13.21***	
V			14.79***	
AD				-2.36*

* 1.96 = 5% level of confidence
** 2.58 = 1% level of confidence
*** 3.29 = 0.1% level of confidence

A minus sign indicates that the group listed on the side is superior to the group listed across the top.

Table 6 shows the relative "weights" of four factors as determined by a least squares analysis. The constant K has the same meaning as in the first study. (i.e., it indicates previous knowledge of the subject). From the table it appears that the audio factor is somewhat more important than the video factor. However, the over-all effectiveness of this film is not equal to the sum of the weights of these two elements, but to this sum minus another factor, the "both" factor, which takes into account the overlapping of the audio and video elements.

The "both" factors for the two aerodynamics films were positive, (i.e. carried a + sign). It would thus appear that the "both" factor for a film, depending on the film and the population, may be either plus or minus. A plus "both" factor indicates that certain items of information are imparted only by the audio and video channels acting together, whereas a minus "both" factor indicates that the teaching of certain items is common to the two channels (i.e., there is some overlapping).

Discussion of Results

The test scores obtained by the audio and video groups in the studies reported here depend to a considerable extent on the relative number of items in the tests that measure information conveyed through the audio or the video channels. If a much larger number of video items than audio items is included in the test, the video group has an opportunity to earn a higher score than the audio group. Whether it will do so depends on the efficiency of the video medium or channel as compared with the audio channel.

In these studies we are concerned with the over-all effectiveness of the video and audio channels. The relative efficiency of these channels has some weight in determining the over-all effectiveness, but the two concepts, over-all effectiveness and relative efficiency, are not synonymous. For instance, if, after exhausting all the information in a film, in constructing a test, we find that we have 20 video items and 100 audio items, and if the efficiency of the video channel is 90 per cent and the audio channel only 50 per cent, then the subjects can be expected to learn correctly 18 of the video items and 50 of the audio items. The over-all effectiveness of the audio medium or channel remains greater than the video in this example, even though it was postulated that the video medium was much more efficient. Efficiency by itself is not necessarily of great importance; what is important is the gross impact or total amount of information imparted by the medium, i.e., its over-all effectiveness. If a learning situation happened to have one olfactory item, and if everybody remembered it out of 100 items in that learning situation, we would not therefore consider the olfactory medium an effective medium for transmitting information, as it transmitted only a very small proportion of the total information in the learning situation.

TABLE 6

Land and Live in the Desert Study

RELATIVE WEIGHTS OF THE FACTORS MAKING UP THE TOTAL SCORES

V = 16.50

A = 18.26

B = -6.57

K = 29.10

V = Video

A = Audio

B = Both

K = Control Group Constant

As regards the relative numbers of audio and video items that should be included in the test, it is apparent from the preceding discussion that for the purpose of determining the over-all effectiveness of each channel, rather than its efficiency, the numbers of such items need not necessarily be equal. Rather, they should exhaust the information in the film, preferably, or else sample the film in a representative fashion.

Of course, it would be valuable to know the relative efficiency of the two channels, visual and auditory, so that if one could be demonstrated to be more efficient than the other, more emphasis could be given to this channel in making a film. However, this imposes extremely difficult experimental problems. Experimental films would have to be produced which contained equal numbers of visual and auditory items, and we would have to find some way of knowing that these are of equal difficulty. To have unequal numbers of video and audio items would be unsatisfactory, because it is probably easier to learn a high proportion of a small number of items than a high proportion of a large number of items.

One further problem to be considered is the nature of the interaction between the audio and video channels. The mathematical model used in determining the weights of these factors assumed a simple additive relationship (Video + Audio + "Both" + a Constant = Mean Score). The net effect of the interaction (the "both" factor) was also assumed to be additive. The psychological relationships between the factors are very likely to be more complicated than the simple additive relationship of the mathematical model used. However, there is no unique way of determining what other mathematical model to adopt. Also, the amount of information obtained in this study is not sufficient to warrant a more complicated analysis. In subsequent studies it may be desirable to postulate a number of mathematical models and determine the extent to which each explains the obtained score.

CONCLUSIONS

These experiments on the effectiveness of the audio and video channels in instructional films contribute more, possibly, to an understanding of the nature of the problem than they do by way of supplying definitive answers. The following may be concluded from the studies:

1. A significant amount of learning accrued from the presentation of the film as a whole and from the presentation of either the video or the audio channel alone.

2. Neither channel was consistently better than the other. The relative effectiveness seems to depend on the particular film and its content. For a given film one channel may be more effective than the other at a significant level.

3. Both channels together were more effective than either one alone.

4. The effectiveness of the film as a whole may be more or less than the sum of the contributions of the two channels separately. In some instances there may be some degree of overlap between the two channels; in other instances, both channels together are necessary to impart certain information.

5. In general, hearing the sound track in a darkened room appears to be slightly superior to hearing the sound track in a lighted room.

IMPLICATIONS

1. Both the audio and the video portions of films are effective channels of communication. Each channel is uniquely capable of conveying certain types of information. However, since both channels together are more effective than either one alone, the object should be to achieve the best possible integration between the video and audio elements of films.

2. The findings of these studies appear to be relevant to television.